

AMENDMENTS TO THE CLAIMS

1. (currently amended) An image processing apparatus comprising:
gradient calculation means for calculating at least the direction of the level gradient of each of a plurality of processing units in a given image data including a plurality of pixels, the pixels respectively having level data;
line segment formation means for producing line segment image data representing a line segment for each of the plurality of processing units, the line segment formation means including means for setting a line segment length L, the line segment formation means being arranged and configured to form each line segment segments having a given said length L, and a direction corresponding to the direction of each level gradient which is calculated by said gradient calculation means; and
line segment image storage means for storing the line segment image data produced by said line segment formation means.
2. (original) The image processing apparatus according to claim 1, further comprising
image storage means for storing said given image data.
3. (previously presented) The image processing apparatus according to claim 1, further comprising
image data extraction means for extracting image data in a processing region set in input image data and feeding the extracted image data to said gradient calculation means.
4. (original) The image processing apparatus according to claim 3, further comprising means for setting said processing region.
5. (previously presented) The image processing apparatus according to claim 1, wherein said line segment formation means produces line segment image data at a gray level.

6. (previously presented) The image processing apparatus according to claim 1, wherein

said line segment formation means produces line segment image data at a binary level.

7. (previously presented) The image processing apparatus according to claim 1, wherein

said gradient calculation means calculates the magnitude of the level gradient in addition to the direction of the level gradient.

8. (previously presented) The image processing apparatus according to claim 1, wherein

said gradient calculation means calculates the magnitude of the level gradient in addition to the direction of the level gradient, and

said line segment formation means produces line segment image data having a level corresponding to the magnitude of the level gradient which is calculated by said gradient calculation means.

9. (previously presented) The image processing apparatus according to claim 1, wherein

said gradient calculation means calculates the magnitude of the level gradient in addition to the direction of the level gradient, and

said line segment formation means produces line segment image data only when the magnitude of the level gradient which is calculated by said gradient calculation means is not less than a predetermined threshold.

10. (previously presented) The image processing apparatus according to claim 1, wherein

said line segment image storage means adds new line segment image data to line segment image data already stored at each of the pixels, and stores the result of the addition.

11. (previously presented) The image processing apparatus according to claim 1, wherein

said line segment image storage means stores new line segment image data without subjecting the line segment image data to addition processing.

12. (currently amended) The image processing apparatus according to claim 1, wherein

said line segment formation means produces a line segment having a ~~predetermined~~ line segment length L in a direction corresponding to the calculated direction of the level gradient from the position of the processing unit.

13. (previously presented) The image processing apparatus according to claim 1, wherein

said line segment formation means produces, when the distance from the position of the processing unit to an initial point and the distance from the processing unit to a terminal point are specified, a line segment from said initial point to said terminal point in a direction corresponding to the calculated direction of the level gradient.

14. (original) The image processing apparatus according to claim 12, further comprising

means for setting the length of the line segment.

15. (original) The image processing apparatus according to claim 13, further comprising

means for setting at least one of the distance from the processing unit to the initial point and the distance from the processing unit to the terminal point.

16. (currently amended) The image processing apparatus according to claim 1, further comprising

means for detecting a portion of the given image data where line segments represented by the line segment image data stored in said line segment image storage means are concentrated.

17. (previously presented) The image processing apparatus according to claim 1, further comprising

means for detecting the position of the pixel having the maximum of the levels of the line segment image data stored in said line segment image storing means.

18. (original) The image processing apparatus according to claim 17, further comprising

means for judging whether or not said maximum level exceeds a predetermined threshold.

19. (previously presented) The image processing apparatus according to claim 1, further comprising

image input means having a camera for producing image data and feeding the produced image data to said gradient calculation means.

20. (previously presented) The image processing apparatus according to claim 1, further comprising

a display device for displaying a line segment image represented by the line segment image data produced by said line segment formation means or the line segment image data stored in said line segment image storage means.

21. (original) The image processing apparatus according to claim 20, wherein said display device displays an image represented by said given image data with the image overlapped with said line segment image.

22. (original) The image processing apparatus according to claim 20 further comprising
means for extracting an edge of the image represented by said given image data,
said display device displaying an image represented by the extracted edge with the
image overlapped with said line segment image.

23. (original) The image processing apparatus according to claim 16, further comprising
a display device for displaying a mark representing the portion, where the line
segments are concentrated, detected by said detection means with the mark overlapped
with the image represented by said image data.

24. (original) The image processing apparatus according to claim 17, further comprising
a display device for displaying, at the position of the pixel having the maximum level
which is detected by said detection means, a mark indicating that the pixel has the
maximum level with the mark overlapped with the image represented by said image data.

25. (original) The image processing apparatus according to claim 18, further comprising
a display device for displaying, at the position of a pixel having the maximum level
which is judged to exceed a threshold by said judgment means, a mark indicating that the
pixel has the maximum level with the mark overlapped with the image represented by said
image data.

26. (previously presented) The image processing apparatus according to claim 23,
further comprising
means for extracting an edge of the image represented by said image data,

said display device displaying an image represented by the edge extracted by said edge extraction means in addition to or in place of the image represented by said image data.

27. (original) The image processing apparatus according to claim 26, wherein said display device displays the line segment image represented by said line segment image data with the line segment image further overlapped with the image represented by the edge.

28. (currently amended) An image processing apparatus comprising:
an image processing means for calculating at least the direction of the level gradient of each of a plurality of processing units in given image data, and producing line segment data representing a line segment for each of the plurality of processing units, said image processing means including means for predetermining a line segment length L, the image processing means being arranged and configured to form each line segment segments having ~~[[a]]~~ said predetermined length L and a direction corresponding to the calculated direction of the level gradient for each image data having a non-zero level gradient; and
display means for displaying the line segment images represented by the line segment image data produced by said image processing means.

29. (original) The image processing apparatus according to claim 28, wherein said display device displays the image represented by said image data with the image overlapped with said line segment image.

30. (original) The image processing apparatus according to claim 29, further comprising
means for extracting an edge of the image represented by said image data,
said display device displaying an image represented by the edge extracted by said edge extraction means in addition to or in place of the image represented by said image data.

31. (currently amended) An image processing method comprising the steps of:
calculating at least the direction of the level gradient of each of a plurality of
processing units in given image data including a plurality of pixels, the pixels respectively
having level data;

providing a predetermined line segment length;

producing line segment image data representing a line segment for each of the
plurality of processing units, each line segment having [[a]] said predetermined line
segment length and a direction corresponding to the calculated direction of the level
gradient for each pixel having a non-zero level gradient; and

storing the produced line segment image data in storage means.

32. (currently amended) A medium storing a program for controlling a computer
so as to:

calculate at least the direction of the level gradient of each of a plurality of
processing units in given image data including a plurality of pixels, the pixels respectively
having level data;

provide a predetermined line segment length;

produce line segment image data representing a line segment for each of the
plurality of processing units, each line segment having [[a]] said predetermined line
segment length and a direction corresponding to the calculated direction of the level
gradient for each pixel having a non-zero level gradient; and

store the produced line segment image data in storage means.

33. (currently amended) An image processing method comprising:
calculating at least the direction of the level gradient of each of a plurality of
processing units in given image data;

providing a predetermined line segment length;

producing line segment image data representing a line segment for each of the
plurality of processing units, each line segment having [[a]] said predetermined line

segment length and a direction corresponding to the calculated direction of the level gradient for each image data having a non-zero level gradient; and

displaying line segment images represented by the produced line segment image data on a display device.

34. (currently amended) A medium storing a program for controlling a computer so as to:

calculate at least the direction of the level gradient for each of a plurality of processing units in given image data,

provide a predetermined line segment length, and

produce line segment image data representing a line segment for each of the plurality of processing units, each line segment having [[a]] said predetermined line segment length and a direction corresponding to the calculated direction of the level gradient for each processing unit having a non-zero level gradient; and

display line segment images represented by the produced line segment image data on a display device.

35. (currently amended) An image processing apparatus comprising:

means for extracting a plurality of edges whose level gradients are not less than a predetermined value in given image data;

means for providing a predetermined line segment length;

means for setting, for each of the edges, a line segment extending [[a]] said predetermined length in a direction corresponding to the direction of the extracted edge; and

means for detecting the presence or absence of a point of intersection of a plurality of line segments and the position thereof.

36. (original) The image processing apparatus according to claim 35, wherein the direction of the line segment is a direction perpendicular to the direction of the edge or the same direction as the direction of the edge.

37. (currently amended) An inspection apparatus comprising:

image input means for inputting image data representing an inspection object;

means for specifying a line segment length;

means for calculating at least the direction of the level gradient of each of a plurality of processing units in said input image data, and producing line segment image data representing a line segment for each of the plurality of processing units, each line segment having [[a]] said specified line segment length and a direction corresponding to the calculated direction of the level gradient; and

means for detecting the presence or absence of a portion where the line segments are concentrated or are overlapped with one another and the position thereof on the basis of the produced line segment image data.

38. (original) The inspection apparatus according to claim 37, wherein

the direction corresponding to the direction of said level gradient is the direction of the level gradient or a direction perpendicular to the direction of the level gradient.

39. (original) The inspection apparatus according to claim 38, further comprising

a display device for displaying the line segment image on the basis of said line segment image data.

40. (original) The inspection apparatus according to claim 39, wherein

said display device displays an image of the object represented by said input image data with the image overlapped with the line segment image.

41. (previously presented) The inspection apparatus according to claim 37, further comprising

a display device for displaying the detected position of the portion where the line segment images are concentrated or are overlapped with one another on the image of the

object represented by said input image data or an image represented by an edge extracted from said input image data.

42. (previously presented) The inspection apparatus according to claim 37, further comprising

means for inputting data relating to the length of the line segment or the initial point and the terminal point of the line segment.

Claims 43-47 (canceled).

48. (currently amended) An image processing apparatus comprising:

a gradient calculator which calculates at least the direction of the level gradient of a processing unit in a given image data including a plurality of pixels, the pixels respectively having level data;

a line segment length provider which provides a line segment length;

a line segment former which produces line segment image data representing a line segment having ~~a given~~ said line segment length and a direction corresponding to the direction of the level gradient which is calculated by said gradient calculation means; and

line segment image storage which stores the line segment image data produced by said line segment formation means.

49. (previously presented) The image processing apparatus according to claim 8, further comprising means for detecting a level value of the line segment image data for each of the plurality of processing units in the given image.

50. (previously presented) The image processing apparatus according to claim 49, further comprising means for determining a concentration of level values in a processing region.

51. (previously presented) The image processing method according to claim 31, further comprising calculating a magnitude of the level gradient of each of the plurality of processing units in the given image data; and

producing the line segment image data to include a level value corresponding to the magnitude of the level gradient.

52. (previously presented) The image processing method of claim 51, further comprising detecting a level value of the line segment image data for each of the plurality of processing units in the given image.

53. (previously presented) The image processing method according to claim 52, further comprising determining a concentration of level values in a processing region.

54. (previously presented) The inspection apparatus of claim 37, wherein the means for calculating determines a magnitude of the level gradient of each of the plurality of processing units, and produces line segment data including level values corresponding to respective magnitudes of the level gradient.

55. (previously presented) The inspection apparatus of claim 54, wherein the means for detecting recognizes coordinates for all processing units on each line segment and calculates a level value held by processing units in a processing region.

56. (new) An image processing apparatus comprising:

gradient calculation means for calculating at least the direction of the level gradient of each of a plurality of processing units in given image data including a plurality of pixels, the pixels respectively having level data;

line segment formation means for producing line segment image data representing a line segment for each of the plurality of processing units, the line segment formation means being arranged and configured to form line segments each having a respective given length

L, and a direction corresponding respectively to the direction of each level gradient which is calculated by said gradient calculation means;

means for varying the length L prior to forming said line segments; and

line segment image storage means for storing the line segment image data produced by said line segment formation means.

57. (new) An image processing apparatus comprising:

gradient calculation means for calculating at least the direction of the level gradient of each of a plurality of processing units in given image data including a plurality of pixels, the pixels respectively having level data;

line segment formation means for producing line segment image data representing a line segment for each of the plurality of processing units, each line segment having a given length and a direction corresponding respectively to the direction of each level gradient which is calculated by said gradient calculation means; and

line segment image storage means arranged and configured to store, for each respective pixel through which the line segment passes, the line segment image data produced by said line segment formation means at said respective pixel.

58. (new) The image processing apparatus of claim 57 wherein the line segment image data includes a level, and the data stored includes a respective line segment level for at least one line segment passing through a respective pixel.

59. (new) An apparatus configured and arranged to perform a plurality of types of image processing, including various types of image detection and image recognition, the apparatus comprising:

means for selecting between the plurality of types of image processing;

gradient calculation means for calculating at least the direction of the level gradient of each of a plurality of processing units in given image data including a plurality of pixels, the pixels respectively having level data;

line segment formation means for producing line segment image data representing a line segment for each of the plurality of processing units, each line segment having a given length and a direction corresponding respectively to the direction of each level gradient which is calculated by said gradient calculation means;

means for setting a line segment length associated with a type of image processing selected; and

line segment image storage means for storing the line segment image data produced by said line segment formation means.

60. (new) The apparatus according to claim 59, further comprising means for selecting the direction corresponding to the direction of each level gradient.